APPENDIX

APPENDIX A-1

SCOPE OF WORK

February 9, 1993

SCOPE OF WORK:
STRENGTH EVALUATION AND STRUCTURAL ANALYSIS INVESTIGATION
UNITED STATES FEDERAL BUILDING
517 GOLD AVE. SW
ALBUQUERQUE, NEW MEXICO
BUILDING NO: NM0024ZZ
PROJECT NO: ZTX00210

February 9, 1993

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STRENGTH EVALUATION AND STRUCTURAL ANALYSIS INVESTIGATION
UNITED STATES FEDERAL BUILDING
517 GOLD AVE. SW
ALBUQUERQUE, NEW MEXICO
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1.0 PROJECT SUMMARY

1.1 The General Services Administration (GSA) is considering a strength evaluation and structural analysis investigation of the United States Federal Building at 517 Gold Ave. SW in Albuquerque, New Mexico. A structural investigation completed last year indicated concrete compressive strengths significantly below the design values while additional studies have shown the deflections measured at the site are well above the code prescribed allowables. A seismic investigation of the building also conducted in 1992 revealed that the lateral resistance of the building would not be sufficient to withstand moderate earthquake forces.

1.2 The Professional Services required will be to:

1.2.1 Coordinate with the Buildings' Manager the removal of ceiling systems and floor coverings in specified areas within the building to observe and document crack patterns on the top and bottom surfaces of the floor slabs.

1.2.2 Conduct, coordinate, and schedule with the Buildings' Manager the location, sampling and testing of concrete core-drilled compressive strength specimens from each floor in the building.

1.2.3 Conduct Windsor probe tests on each floor of the building to correlate and verify the consistency of the concrete core-drilled compressive strength tests.

1.2.4 Conduct magnetic rebar locating tests to verify the existence of the reinforcing steel specified on the original structural working drawings.

1.2.5 Perform a complete gravity load structural analysis on the building to determine the live load carrying capacity of each floor system.

1.2.6 Conduct thorough research and perform detailed deflection calculations in order to compare the theoretical deflections of the two-way flat slab system with the actual deflections observed in the field.

1.2.7 Review previous structural and seismic analyses conducted on the building for completeness and accuracy.

1.2.8 Submit a Final report which includes:

a. A summary of the results of all on-site testing and observations.

b. All structural calculations with explanations of all assumptions and methods used in the analysis.

c. Conclusions regarding the actual strength, safety, and overall serviceability of the structure.

d. Separate recommendations with preliminary details and construction cost estimates for any necessary strengthening of the structure to resist:
(1) the current code prescribed minimum live loads and,
(2) the original design live loads specified for the building.

e. Review comments on the previous structural analysis of the building.

f. Review comments, recommendations, and revised construction cost estimates for strengthening the building elements (structural and nonstructural) to resist seismic forces.

2.0 PROJECT BACKGROUND

The United States Federal Building located at 517 Gold Ave. SW in Albuquerque, New Mexico is an 8 story reinforced concrete building constructed around 1958. The structure consists of a two- way flat slab floor system supported every 25'-0" o.c. typically by reinforced concrete columns. The system utilizes drop panels with "lampshade" shearheads designed to resist two-way punching shear at the columns. Spandrel beams frame from column to column along the exterior perimeter of each floor system. The building is rectangular in shape - 300'-0" long by 102'-0" wide. All gravity loads are transferred down the columns to foundations consisting of spread footings. Lateral loads are resisted by shear walls in the elevator core and stairblocks of the building. The building is occupied by GSA, the U.S. Forest Service, the Internal Revenue Service, the Corp of Engineers and other federal agencies.

Structural analyses and a seismic study conducted in 1992 revealed several descrepancies in the original structural working drawings dated 1956. The structural design working drawings and specifications for Concrete and Cement Work for the building require 3000 psi concrete for floor slabs and 3750 psi concrete for columns . However, the specifications and drawings allowed any grade of billet grade reinforcing steel (except structural grade, 33,000 psi yield) in accordance with ASTM 305-49. Therefore, it was not clear from the drawings or specifications which grade of reinforcing steel was actually used. In August of 1992, concrete core samples and a reinforcing steel coupon were obtained from the sixth floor of the building. The average of the three core sample taken were well below the specified 3000 psi while the reinforcing steel was determined to be Grade 60 as opposed to Grade 40 as assumed in previous structural studies. Large deflections were also measured and found to be significant throughout the building.

Using the results of the testing described above, GSA's supplemental A/E for the State of New Mexico performed a strength evaluation and structural analysis to determine the live load carrying capacities of the each floor framing system. In their report dated November 5, 1992, BPLW Architects and Engineers of Albuquerque determined that the floor slabs on the sixth, seventh, and eighth floors lacked adequate shear capacity to support the design live load of 80 PSF. The large deflections measured within the building were stated to be of "grave" concern. (see attachment A)

The profound implications of the recommendations in BPLW's report prompted the General Services Administration to conduct further independent study of the situation. A preliminary structural analysis was conducted by the supplemental A/E for the state of Utah in December of 1992 which, in general, verified the concerns raised by BPLW. This scope of work is based upon the recommendations of the report by Reaveley Engineers dated January 13, 1993. By issuance of this Scope of Work, GSA is seeking a final determination of the overall strength and serviceability of this structure.

3.0 SCOPE OF SERVICES:

3.1 On-site Testing and Data Collection

3.1.1 The A/E shall coordinate with the Buildings Manager the removal of floor coverings and finishes around four (4) interior columns within the building. The locations chosen to be studied should be on different floors and selected to cause the least disruptions to the building tenants. However, two (2) of the locations chosen shall be on the seventh and eighth floors of the building. The top surface of the concrete slabs at the locations specified shall be cleaned and free of all adhesives, dirt, and oils so an accurate and clear observation of the crack patterns can be obtained and documented with photographs. The removal and subsequent replacement of the floor coverings, finishes and adhesives, (including all asbestos abatement required) shall be accomplished by the Buildings Manager's indefinite quantity contractor and is not a part of this stated Scope of Work.

3.1.2 The A/E shall coordinate with the Buildings Manager the removal of the suspended and plaster ceilings within conference room 4210 on the fourth floor. Lighting fixtures, diffusers, etc. should be removed to expose as much of the bottom surface of the 25'-0" X 25'-0" bay as possible. Crack patterns on the bottom surface of the fifth floor slab shall be documented with photographs. The removal and replacement of the ceiling system, lighting, etc., shall be accomplished by the Building Manager's indefinite quantity contractor and is not a part of this stated Scope of Work.

3.1.3 The A/E shall coordinate with the Buildings Manager and specify two (2) locations on each floor to conduct concrete compressive core drill tests. All core drilled holes shall be immediately repaired with cementious grout or epoxy. These tests shall be correlated and verified with six (6) Windsor probe tests per floor. Any removal and replacement of floor coverings and repairs required shall be accomplished by the indefinite quantity contractor in conjunction with the work described in paragraph 3.1.1 above.

3.1.4 The A/E shall conduct magnetic rebar testing at four (4) locations within the building to verify the existence of the reinforcing steel specified on the original structural working drawings.

3.1.5 Using the original working drawings and data gathered at the site, the A/E shall attempt to verify the width and depth of the underfloor electrical duct system for the building.

3.2 Structural Analysis

3.2.1 Using the results of the tests and observations described in paragraph 3.1 above as well as previously obtained test data, the A/E shall perform a complete and thorough gravity load analysis of the two-way flat slab floor system. Typical "equivalent" frames in the north/south and east/west directions shall be studied to determine the live load carrying capacities of each floor. The A/E shall clearly compare in tabular form the actual vs. required moments and shears at critical sections within the equivalent frames. The analysis must comply with ACI 318-89 R92 "Building Code Requirements for Reinforced Concrete."

3.2.2 The A/E shall conduct library research and construct computer models to calculate and compare the theoretical deflections in the slabs to the actual deformations measured in the field. Every effort shall be made to determine the cause(s) for the deflections; poor construction shoring, overload etc. Further investigations shall be made into the effect of shrinkage and creep on the long term deformations of two-way flat slab systems. The influence of the underfloor electrical duct system on the deflections shall be investigated as well. Additionally, calculations shall demonstrate the effect of the deflections on the calculated strength of the structure as determined in 3.2.1 above.

3.3 Review Previous Structural Analyses

3.3.1 The A/E shall review the previous structural analysis dated November 5, 1992 by BPLW, Architects and Engineers, of Albuquerque, New Mexico. The A/E shall compare their assumptions, calculations, test results, and conclusions to those outlined within BPLW's report.

3.3.2 The A/E shall review the seismic analysis dated April 1992 by BPLW, Architects and Engineers. The A/E shall perform any additional structural calculations as needed to review the assumptions, methods, conclusions, and recommendations detailed within BPLW's report. The A/E shall also review all cost estimates associated with the recommended seismic upgrade for accuracy and completeness. The calculations and review shall be in accordance with the 1991 Uniform Building Code and the GSA Seismic Design Guidelines.

3.4 Reports and Recommendations

3.4.1 The A/E shall prepare a Final report which includes but is not limited to the following:

a. A summary and explanation of all on-site observations and testing performed.

b. All photographs and sketches used to document the crack patterns observed within the floor slabs.

c. All structural calculations used in the analysis of the building frames.

d. A summary and interpretation of all structural calculations, assumptions, and methods used in the gravity load structural analysis. The text of the report should discuss the overall ability of the structure to support in flexure and shear: 1. code minimum design live loads and, 2. the original design live loads. The report shall clearly state in tabular form the live load carrying capacity of each floor system.

e. A summary and explanation of all research and calculations associated with the slab deflections. The cause(s) for the deflections observed shall be thoroughly discussed. The report should relate the deflections to the actual strengths of the two-way slab systems.

f. Review comments on the Structural Analysis report and calculations by BPLW, Architects and Engineers, dated November 5, 1992.

g. Review comments on the Seismic Analysis report and calculations by BPLW, Architects and Engineers, dated April 1992.

h. Recommendations for strengthening the structure to resist:
   (1) code minimum live loads
   (2) original design live loads
   (3) seismic forces

   These recommendations shall be accompanied by preliminary details and detailed construction cost estimates in CSI format. The seismic recommendations, details, and cost estimates shall be based on the review of the BPLW study. The seismic recommendations and cost estimates shall be divided into structural and nonstructural elements.

i. General recommendations for future utilization of the facility considering the overall strength, safety, and serviceability of the structure. The A/E shall categorize their recommendations and comments according to:
   (1) Life Safety issues - recommendations that are immediately essential to the safety of the building tenants and occupants.
   (2) Short Term Issues - recommendations that should be accomplished within the next five (5) years.
   (3) Long Term Issues - recommendations that could be acceptably accomplished within the next five to ten (5 - 10) years.

3.4.2 The A/E shall deliver to the General Services Administration, Design and Construction Division, five (5) copies of the report and calculations according to the following schedule:

a. Prefinal (90%) sixty (60) calendar days from the Notice to Proceed. GSA review time will be fourteen (14) days.

b. Final (100%) ninety (90) calendar days from the Notice to Proceed. The A/E shall prepare a presentation to be delivered at GSA's regional headquarters in Fort Worth, Texas at the final submittal.

4.0 ATTACHMENTS

4.1 Attachment A - Structural Floor Analysis, Final 100% Report, Federal Building, 517 Gold Ave. SW, Albuquerque, New Mexico, BPLW Architects and Engineers, Inc.

4.2 Attachment B - Seismic Analysis, Final 100% Report, Federal Building, 517 Gold Ave. SW, Albuquerque, New Mexico, BPLW Architects and Engineers, Inc.

4.3 Attachment C - Architectural and Structural Drawings, U.S. Federal Building, Albuquerque, New Mexico

5.0 REFERENCES

Any questions or conflicts which arise with this stated Scope of Work shall be referred to:

Tracy Alton Graham, P.E.
Structural Engineer
General Services Administration
Public Buildings Service
Design and Construction Division
819 Taylor Street, 7PCPT
Fort Worth, Texas 76102
(817) 334-2570

Albuquerque point of contact:

Ms. Carolyn Briones
Buildings Manager
General Services Administration
(505) 766-2101

APPENDIX A-2

STRUCTURAL SUPPORT DATA

APPENDIX A-2

STRUCTURAL SUPPORT DATA

CONCRETE TEST RESULTS - STRENGTH TESTS

SHB AGRA, INC.
Engineering & Environmental Services

4700 Lincoln Road NE
Albuquerque, New Mexico
U.S.A. 87109
Phone: 505-884-0950
Fax: 505-884-1694

September 15, 1993

Reaveley Engineering
1515 S 1100 E
Salt Lake City, UT 84105

SHB AGRA Job No. C93-5861

Attn: Jeff Miller

Re: Federal Building Concrete Testing
517 Gold St.
Albuquerque, NM

Gentlemen,

As requested, SHB AGRA conducted concrete sampling and testing at the referenced building.

Our scope of work consisted of obtaining core samples and Windor Probe determinations (ASTM C-803) on each of the floor slabs, and at the indicated locations the core samples were obtained and tested in accordance to ASTM C-42.

The compressive strength and the windsor probe results are presented in Tables 1 and 2, respectively.

If you have any questions or comments please contact our office at (505) 884-0950.

Respectfully Submitted,
SHB AGRA, Inc.

By____________________
Robert S. Romero
Manager of Construction Services

Reviewed By____________________
Guillermo A. Florentino, P.E.
Materials Engineer

TABLE 1

Core No.	Floor, Location	Strength (PSI)
1	8th, W Mech room	2490
2	8th, Hallway room 8023	2470
3	2nd, W Mech room SW corner	2260
4	2nd, W Mech room NE corner	2570
5	7th, W Mech room	1870
6	7th, W Mech room	2550
7	6th, W Mech room	1910
8	6th, E Mech room	N/A
9	5th, Hall room 5D14	2140
10	5th, W Mech room	2050
11	4th, W Mech room, W side	1980
12	4th, W Mech room, N side	1840
13	3rd, W Mech room, N side	1810
14	3rd, W Mech room, W side	2150
15	1st, E Mech room, NW corner	2380

TABLE 2

REPORT OF PENETRATION RESISTANCE - ASTM C803

PROJECT: Federal Building Concrete Testing SHB JOB NO. C93-5861
TRUCTURE: Floor Slabs DATE: 8-25-93
ONCRETE DESCRIPTION:
MOHS' HARDNESS OF COARSE AGGREGATE: 6 AGE: 40 years
URFACE FINISHING TECHNIQUE: Floated Finish
PPROXIMATE THICKNESS OF CONCRETE TESTED: 8"
DRIVER UNIT SERIAL NUMBER:

LOCATION	ENERGY LEVEL	PROBE REGISTRY NUMBER	AGE	EXPOSED LENGTH (in)	COMPRESSIVE STRENGTH (PSI)
2nd Floor W Mech room SW corner	High	654012		2.150	2230
2nd Floor W Mech room SW corner	High	654012		2.050	2130
2nd Floor E Mech room 2.5' W of E wall	High	654012		2.225	2310
2nd Floor E Mech room 5' W of E wall	High	653958		2.125	2200
2nd Floor E Mech room 2' N of S wall	High	653958		2.225	2308
2nd Floor E Mech room 12' N of S wall	High	653958		2.250	2330
8th Floor W Mech room 8' E of W wall	High	653788		2.100	2180
8th Floor W Mech room 5' S of N wall	High	653788		2.000	2080
8th Floor Hall room 8023	High	653966		2.075	2150
8th Floor E Mech room	High	653966		2.100	2180

AGRA
Earth & Environmental Group

REPORT OF PENETRATION RESISTANCE - ASTM C803

ROJECT: Federal Building Concrete Testing SHB JOB NO. C93-5861
TRUCTURE: Floor Slabs DATE: 8-25-93
ONCRETE DESCRIPTION:
OHS' HARDNESS OF COARSE AGGREGATE: 6 AGE: 40 years
URFACE FINISHING TECHNIQUE: Floated Finish
PPROXIMATE THICKNESS OF CONCRETE TESTED: 8"
RIVER UNIT SERIAL NUMBER:

LOCATION	ENERGY LEVEL	PROBE REGISTRY NUMBER	AGE	EXPOSED LENGTH (in)	COMPRESSIVE STRENGTH (PSI)
4th Floor W Mech room 1' W of E wall	High	653802		2.225	2310
4th Floor W Mech room 2' S of N wall	High	653802		2.150	2230
4th Floor W Mech room 10' S of N wall	High	653802		2.125	2100
4th Floor W Mech room 5' W of E wall	High	653745		2.025	2180
4th Floor W Mech room 1' W of E wall	High	653745		2.100	2200
3rd Floor W Mech room 1' E of W wall	High	653745		2.125	2260
3rd Floor W Mech room 10' S of N wall	High	653807		2.175	2200
3rd Floor E Mech room 1'W of E wall	High	653807		2.125	2200
3rd Floor E Mech room 5' W of E wall	High	653807		2.125	2200
3rd Floor Mech room 3' S of N wall	High	653931		2.150	2230

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REPORT OF PENETRATION RESISTANCE - ASTM C803

PROJECT: Federal Building Concrete Testing SHB JOB NO. C93-5861
STRUCTURE: Floor Slabs DATE: 8-25-93
CONCRETE DESCRIPTION:
MOHS' HARDNESS OF COARSE AGGREGATE: 6 AGE: 40 years
SURFACE FINISHING TECHNIQUE: Floated Finish
APPROXIMATE THICKNESS OF CONCRETE TESTED: 8"
DRIVER UNIT SERIAL NUMBER:

LOCATION	ENERGY LEVEL	PROBE REGISTRY NUMBER	AGE	EXPOSED LENGTH (in)	COMPRESSIVE STRENGTH (PSI)
6th Floor Hall room 6431	High	653931		2.050	2130
6th Floor E Mech room 5′ S of N wall	High	654051		2.125	2200
6th Floor E Mech room 10′ S of N wall	High	654051		2.100	2180
8th Floor Hallway E of 8023	High	654051		2.050	2130
5th Floor W of Mech room 3′ S of N wall	High	653789		2.225	2310
5th Floor Hall W of 5014	High	653789		2.100	2280
5th Floor E Mech room 5′ W of E wall	High	653789		2.000	2080
5th Floor E Mech room 5′ N of S wall	High	653783		1.950	2020
5th Floor E Mech room 10′ N of S wall	High	653783		2.100	2180
4th Floor W Mech room 3′ E of W wall	High	653783		2.125	2200

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REPORT OF PENETRATION RESISTANCE - ASTM C803

PROJECT: Federal Building Concrete Testing SHB JOB NO. C93-5861
STRUCTURE: Floor Slabs DATE: 8-25-93
CONCRETE DESCRIPTION:
MOHS' HARDNESS OF COARSE AGGREGATE: 6 AGE: 40 years
SURFACE FINISHING TECHNIQUE: Floated Finish
APPROXIMATE THICKNESS OF CONCRETE TESTED: 8"
DRIVER UNIT SERIAL NUMBER:

LOCATION	ENERGY LEVEL	PROBE REGISTRY NUMBER	AGE	EXPOSED LENGTH (in)	COMPRESSIVE STRENGTH (PSI)
8th Floor E Mech room 6' W of E wall	High	653466		2.125	2200
7th Floor Mech room 2' S of N wall	High	653466		2.200	2280
7th Floor Mech room 2' S of N wall	High	653996		2.150	2230
7th Floor Mech room 12' S of N wall	High	653996		2.125	1920
7th Floor room #7031	High	653996		1.850	1920
7th Floor E Mech room 5' W of E wall	High	653969		2.075	2150
7th Floor E Mech room 5' N of S wall	High	653969		2.050	2130
6th Floor W Mech room	High	653969		2.175	2260
6th Floor room 6429 3' S of N wall	High	653774		2.050	2130
6th Floor room 6429 6' W of E wall	High	653774		2.150	2230

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REPORT OF PENETRATION RESISTANCE - ASTM C803

PROJECT: Federal Building Concrete Testing SHB JOB NO. C93-5861
STRUCTURE: Floor Slabs DATE: 8-25-93
CONCRETE DESCRIPTION:
MOHS' HARDNESS OF COARSE AGGREGATE: 6 AGE: 40 years
SURFACE FINISHING TECHNIQUE: Floated Finish
APPROXIMATE THICKNESS OF CONCRETE TESTED: 8"
DRIVER UNIT SERIAL NUMBER:

LOCATION	ENERGY LEVEL	PROBE REGISTRY NUMBER	AGE	EXPOSED LENGTH (in)	COMPRESSIVE STRENGTH (PSI)
3rd Floor E Mech room 10' N of S wall	High	663931		2.075	2150
1st Floor W Mech room 1' E of W wall	High	663931		2.050	2130
1st Floor W Mech room 5' E of W wall	High	653781		2.150	2230
1st Floor W Mech room 2' S of N wall	High	653781		2.050	2130
1st Floor W Mech room 10' S of N wall	High	653781		1.975	2050
1st Floor E wall	High	664091		2075	2150
1st Floor E Mech room S wall	High	664091		2100	2180

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APPENDIX A-2

STRUCTURAL SUPPORT DATA

CONC. TEST RESULTS - PETROGRAPHIC EXAMINATION REPORT BY HI TECH CONSULTING

REPORT ON
PETROGRAPHIC EXAMINATION AND
AIR-VOID SYSTEM ANALYSIS OF
CONCRETE CORES

Reaveley Engineers
October 4,1993

INTRODUCTION

Two concrete cores, identified as Core #16 (1st floor, east machine room, 5 ft. N. of south wall), and Core # 6th floor were received September 15, 1993 from Mr. Jeff Miller of Reaveley Engineers, Salt Lake City, Utah.

The samples are from floor slabs on the 1st and 6th floors of the Federal Building in Albuquerque, New Mexico. The floor slabs are experiencing loss of rigidity, causing slumping and pulling of the edges away from the support columns.

Petrographic examination, air-void analysis and water/cement ratio analysis were requested to help determine the cause of the loss of strength. This initial report contains the results of the petrographic examination and void analysis.

LABORATORY TESTING METHODS

Cores were first examined and then submitted to Pioneer Thin Sections, Draper, Utah, for the preparation of petrographic thin sections, as follows. Each core was sawed in half longitudinally, and thin section blocks (2X3XI in.) cutfrom the long axis of the core for Core #16 and at right angle to the long axis from Core #6 due to the small size of the sample. The blocks were vacuum impregnated with epoxy, and made into large area polished thin sections mounted on glass microscope slides, 2 in.X 3 in. and approximately 20 microns thick. One additional slide was prepared from Core#16after the origional set using fluorescent epoxy to highlight cracks and pores.

Petrographic Examination

Petrographic examination was performed on both cores in accordance with ASTM C856 "Standard Practice for Petrographic Examination of Hardened Concrete". Thin sections were examined using a polarizing petrographic microscope at magnifications up to 250X, to evaluate the minerology, micromorphology, and evidence for deterioration mechanisms. Results of the petrographic esamination are presented in the attached data forms.

AIR-VOID ANALYSIS

Air-void system analysis was performed using the linear traverse method at a magnification of 100X, in accordance with

ASTM C457, "Standard Practice for Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete". One 1/2 in. thick slab taken from the middle of Core #16 was polished on both sides to provide the required surface area for analysis. Results are in the attached air-void analysis data form.

CONCLUSIONS

The weakness of the concrete appears due to A) extensive carbonation of the concrete matrix, B) some microcracking due to alkali-silica reactions between the cement paste and high energy quartz aggregates, and C)a low bag mix (possibly around 5 bags) as indicated by the high sand content in the cured concrete.

The concrete is air entrained in both cores, with Core #16 containing 4.84% total air, which includes 3.44% entrained and 1.40% entrapped air. The specific surface of 222.2 sq.in./cu. in. and spacing factor of 0.025 in. is low for exterior freeze/thaw protection, but should be sufficient for the interior application present in this study. The poor condition of the 6th floor core thin section made estimation of air-void content impossible.

The matrix of the concrete was evidently too soft for standard thin section preparation methods, and severe plucking occurred, creating large areas of incomplete sample matrix.

Minor inter- and intra-grain microcracking occurs throughout both cores, but they are short and isolated.

The aggregate contains rock types which are typically alkali-reactive. These include fine-grained volcanics (including some devitrified) comprising approx. 35% of the aggregate, and highly undulose quartzite also comprising about 35%. The protected enviroment of the office building will slow the potential damage due to the alkali-silica reactions, but they will continue to be a long-term source of strength problems.

Carbonation, normally extending only a few mm below the surface is present in varying degrees throughout the cores. While the surface and various scattered areas approach 100%, the average matrix is about 30-50% carbonated. It is not clear what is the source of the carbonation.

Respectfully submitted,

Frank Strickland, M.S.
Petrographer

CONCRETE PETROGRAPHIC DATA

Sample ID: Core #16 Date: October 4,1993
Project: Reaveley Eng.(Albuq. Federal Bldg)

Sample Type
Core: Diameter: 2 3/4 in. Length: 5 1/2 in.
Orientation: Long axis perpendicular to outer surface.

Purpose
Petrographic examination of hardened concrete (by ASTM C856) to determine the cause of deterioration.

::

Surfaces
Top surface: Grey epoxy coating, no surface relief

Bottom Surface: Broken core bottom. Surface broke around most particles and through a few. The color is greyish white and exposed particles are coated with the paste.

Coarse Aggregate
Type: Predominantly gravel derived from volcanic rock (rhyolite and andesite) along with highly strained orthoquartzite, each accounting for about 35% of the total aggregate. Undulatory extinction angles up to 32° were measured, although most are around 10 to 12°. Strained quartz is high energy and susceptable to alkali reactivity. Some volcanic and undulose quartz particles have light colored rims similar to alkali-aggregate reaction, but no gel was visible. The carbonation has replaced the quartz rims along 2 sides of a large portion of the exposed quartz grains. Medium grained quartz arenite and fine grained micritic limestone are present as occasional particles. The plagioclase feldspar crystals present in the volcanics and individual grains appear relatively fresh and unaltered.

Top size: 3/4 inch

Shape: Predominantly subrounded, ranging from rounded to subangular.

Gradation: Uniform

Distribution: Uniform

Fine Aggregate
Type: Same lithologic types as coarse aggregate are present, but the dominant type consists of single quartz grains, both plain and undulose. There is a high amount of

fine-grained sand present between the large aggregate. The sand displaces cement paste, resulting in a lower bag mix. An estimated bag mix for this concrete is around 5 bags.

Type: Angular to subangular

Gradation: Uniform in the small grains, but there is a significant disparity between the larger coarse aggregate grains and the fine aggregate with very little intermediate sizes.

Distribution: Uniform

Air-void system: Air entrained.See air void analysis form.

Cracks/microcracks
Core has several microcracks, but they are relatively small and isolated. Some aggregate grains have circumferential cracks, generally only on one side. The cracking in the matrix is minor, isolated and with no preferred direction. Most are 0.3-0.6 mm in length, with the longest around 1.5 mm. The larger grains are also occasionally cracked internally. Some are pre-existing in the aggregate, but others, especially the volcanics, are secondary due to alkali/silica reactions.

Alkali reactivity
Alkali-silica gel partly fills some microcracks at the edges of reactive particles. Most of the edge cracks do not show evidence of alkali-silica gel filling.

Cement Paste Properties
Color: Whitish grey

Luster: Dull

Hardness: Moderate. Softer in highly carbonated portions.

Bond to aggregate: Variable. Many aggregate particles are partially separated from the paste by microcracks.

Depth of carbonation: The carbonation in this sample is unusual in both amount and distribution. Carbonation is present throughout the core in varying amounts. The outside surface is extremely carbonated down to a depth of around 3/8 inch. From there the carbonation is variable with patches of paste almost completely carbonated in a background of 30-50% carbonation. Small areas have minor (10% or less) carbonation. In the paste/aggregate boundaries there is carbonation and/or alkali-silica reaction rims and it is not always easy to differentiate. The carbonation is especially active around the larger air voids. The accompanying photos illustrate the carbonation amount and distribution typical in this core.

CONCRETE PETROGRAPHIC DATA

Sample ID: Core-6th floor Date: 10/4/93
Project: Reveley Engineers (Albuq. Fed. Bldg)

Sample Type
Core: Diameter: 2 3/4 in. Length: 2 1/2 in.
Orientation: Long axis perpendicular to outer surface

Purpose
Petrographic examination of hardened concrete (by ASTM C856) to determine the cause of deterioration.

::

Surfaces
Top Surface: Grey epoxy coating, no surface relief

Bottom surface: Broken core bottom. Surface broke around aggregate particles, leaving a greyish-white coating.

Coarse Aggregate
Type: Same aggregate type as described for Core#16.

Top size: 3/4 in.

Shape: Predominantly subrounded, ranging from rounded to subangular.

Gradation: Uniform

Distribution: Uniform

Fine aggregate
Type: Same lithologic types as Core #16

Shape: Angular to subangular

Gradation: Uniform in the smaller grains, but with the same disparity between the large and small aggregate seen in Core #16.

Distribution: Uniform

Air-Void System
Air entrained, but the poor condition of the petrographic thin section it was not possible to estimate the air void content in this sample.

Cracks/microcracks
The cracks in this core are similar to those in Core #16 in type and distribution. One large volcanic fragment had an especially pronounced fracture separating the particle from the paste.

Alkali Reactivity
Alkali-silica gel partly fill some cracks around

the edges of some of the more reactive aggregate particles. The extent of these reactions is difficult to discern due to extensive carbonation in the matrix around the aggregate.

Cement Paste Properties

Color: Whitish grey

Luster: Dull

Hardness: Moderate. Softer in highly carbonated sections.

Bond to aggregate: Variable. Many aggregate particles are partially separated from the paste by microcracks.

Depth of carbonation: The carbonation in this core is very similar in amount and distribution to that in Core #16. The carbonation in the deeper sections occur more as a pronounced halo around the aggregate grains. The matrix experianced more severe disintigration during thin section preparation, indicating the softening of the matrix due to carbonation and alkali silica reactions may be more pronounced in this core.

LEGEND FOR SYMBOLS USED IN THE PHOTOMICROGRAPHS

PL= Plain light
XP= crossed polarized light
/= arrows point to cracks
QTZ= quartz
V= volcanics
VOID= air void
Met= metamorphic fragment
LS= limestone fragment
QTZITE= quartzite